

THE AMERICAN MINERALOGIST

JOURNAL OF THE MINERALOGICAL SOCIETY OF AMERICA

Vol. 18

MARCH, 1933

No. 3

THE NEW MINERALOGY*

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It is surely worth while for us to pause a moment in this time of rapid advance of all scientific knowledge to consider the present and future state of mineralogical science as compared with that of a generation ago. Such a comparison should serve to bring out the chief advances which have been made and may even suggest some features of the progress that may be expected in the future.

Thirty years ago students of rock components were interested primarily in the surfaces and average composition of minerals; to-day they are studying the internal structure and variations of composition of minerals.

The study of the surfaces of crystallized minerals developed into the science of crystallography and permitted keen thinkers to reach certain correct conclusions regarding the internal structures of crystals, but these conclusions did not attain general acceptance because of lack of definite proof. Our knowledge of crystals resembled that which might be obtained of houses and public buildings, entirely devoid of windows and doors, by a study confined entirely to their exterior surfaces. Thirty years ago the average composition of minerals was determined by chemical analysis, but this gave no information regarding the distribution of the constituents in the crystal and resembled the information one might obtain concerning a public building or palace by completely wrecking it and then measuring the total weight of all the brick, all the stone, all the mortar, all the steel, and all the lumber used in its construction. Nothing would be known regarding the manner of use of the materials in the construction of internal and external walls and the arrangement of rooms and galleries in the original building.

Today the new x -ray methods have enabled us to study the internal structures of crystals and to learn the precise arrangement

* Presidential address presented at the thirteenth annual meeting of *The Mineralogical Society of America*, in joint session with *The Geological Society of America*, Cambridge, Mass., December 29, 1932.

and nature of the constituent parts. The new knowledge of crystals resembles that which would be obtained by making a careful study of all the internal features of a public building or palace which had previously been accessible only to external observation and to study after complete demolition. The mineralogist who had hitherto been barred from entrance has now found an open door into his crystal palace and is using it to learn the whole story of the internal arrangements and nature of walls, rooms and galleries.

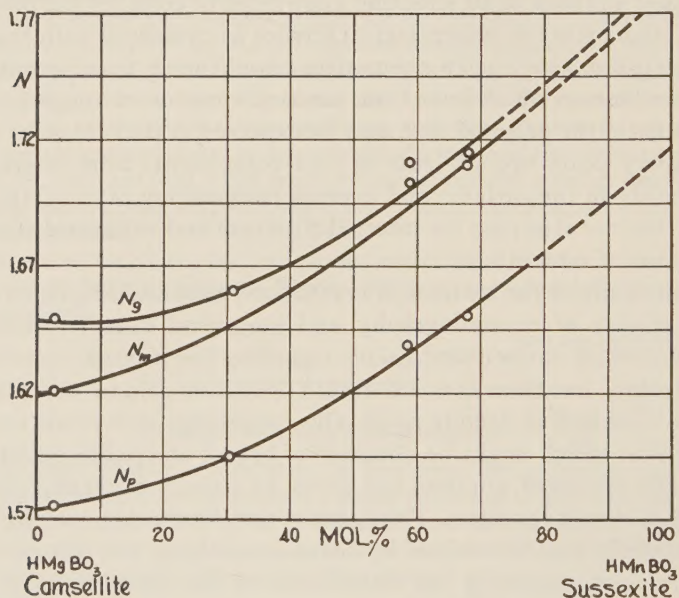


FIG. 1. Variations in composition and optic properties in the camsellite-sussexite series.

Thirty years ago the mineralogist considered that each mineral had some definite and simple composition corresponding with some simple chemical formula. Today he has learned that such a condition is very rare in nature and that nearly all minerals vary considerably in composition. Many minerals may vary in composition continuously from one chemical formula to a different one. Such variations do not change the essential nature of the mineral, although its properties show gradual variations corresponding with the gradual changes in composition. Also, a single mineral may vary in composition in more than one way.

An example of the simplest kind of variation in composition is furnished by the series from camsellite, HMgBO_3 , to sussexite, HMnBO_3 . Such a series is conveniently represented by a line divided into 100 parts so that the percentage composition represented by any point may be read off promptly; also, the variations in properties may be expressed easily by means of a suitable scale on the second coordinate, as illustrated in Fig. 1.

One substance may vary in this way to more than one other substance. For instance, siderite, FeCO_3 , may vary to magnesite,

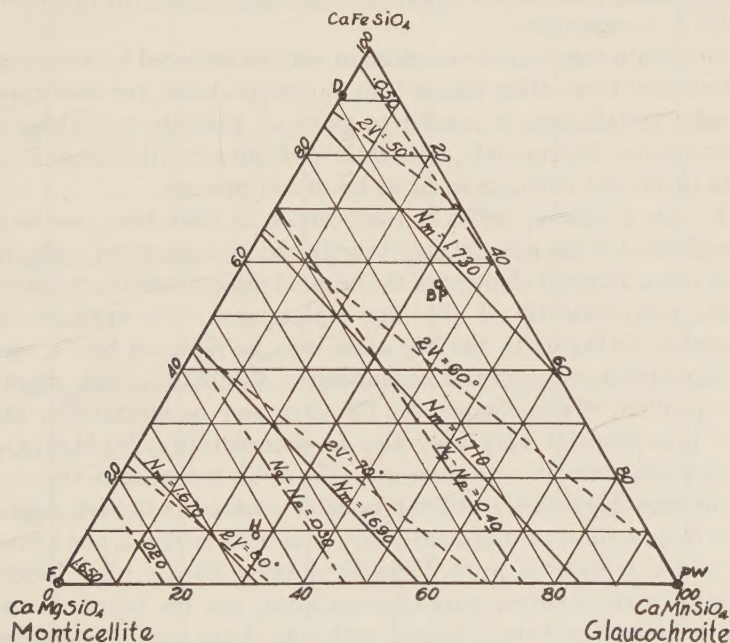


FIG. 2. Variations in composition and optic properties in the glaucophroite-monticellite- CaFeSiO_4 system. Based on data of Beliankin and Ivanov: *Am. Jour. Sci.*, XXII, 1931, p. 72.

MgCO_3 ; or to rhodochrosite, MnCO_3 ; magnesite apparently does not vary directly to rhodochrosite. The main facts regarding such a double series can be shown by merely doubling the length of the horizontal line used to show the variations in composition and still using the other coordinate to express variations in physical properties. This is illustrated by a diagram¹ showing the relations be-

¹ A. N. Winchell, *Am. Mineral.*, XVII, 1932, p. 473.

tween variations in composition and in properties in three kinds of tourmaline.

In some compounds one element may be replaced by any combination of two other elements in any proportions and then all variations in composition can not be represented by a line, but may be shown by a triangle. This is approximately illustrated by the condition in the CaFeSiO_4 — CaMgSiO_4 — CaMnSiO_4 system exhibited in Fig. 2, which shows by means of lines similar to contours the variations in optical properties corresponding with the variations in composition.

In certain compounds one element may be replaced by any combination of three other elements in any proportions; for such cases a solid tetrahedron is needed to show all possible variations in composition. Fortunately, illustrations of this condition seem to be rare in natural minerals so far as known at present.

In case a mineral varies in composition in more than one way, one element in the mineral may be replaced by some other element, and also a different element of the original mineral may be replaced quite independently of the first replacement. For example, in diopside, $\text{CaMgSi}_2\text{O}_6$, the Mg atom may be replaced by Fe, and thus diopside may vary to hedenbergite, $\text{CaFeSi}_2\text{O}_6$, and, wholly independent of this change, the Ca atom may be replaced by Mg and thus diopside may vary also to clinoenstatite, $\text{MgMgSi}_2\text{O}_6$. If diopside varies in both these ways the result is obviously clinohypersthene, $\text{MgFeSi}_2\text{O}_6$. All the possible variations in such a system may be shown conveniently on a square, as in Fig. 3, one corner of which represents pure diopside, another corner pure hedenbergite, a third corner pure clinoenstatite, and the fourth corner pure clinohypersthene. Then, if each side of the square is divided into one hundred parts, these divisions will show the percentage composition represented by any point. Thus, in Fig. 3 the point A on the base line represents 57% of hedenbergite and 43% of diopside, the point B on the left hand side represents 39% of clinoenstatite and 61% of diopside. Similarly a point C inside the square represents 29% of the Mg-Fe change (or 29% hedenbergite+clinohypersthene) and 42% of the Ca-Mg change (or 42% clinoenstatite+clinohypersthene); therefore it represents 29% of 42% or 12.2% of clinohypersthene. In an entirely similar way the percentage composition represented by any point in the square in terms of the four end-member molecules may be obtained readily from the figure.

The relations between optic properties and chemical composition in this system are shown in Fig. 4. Known examples of clinohypersthene are so rare that the optic properties of that substance

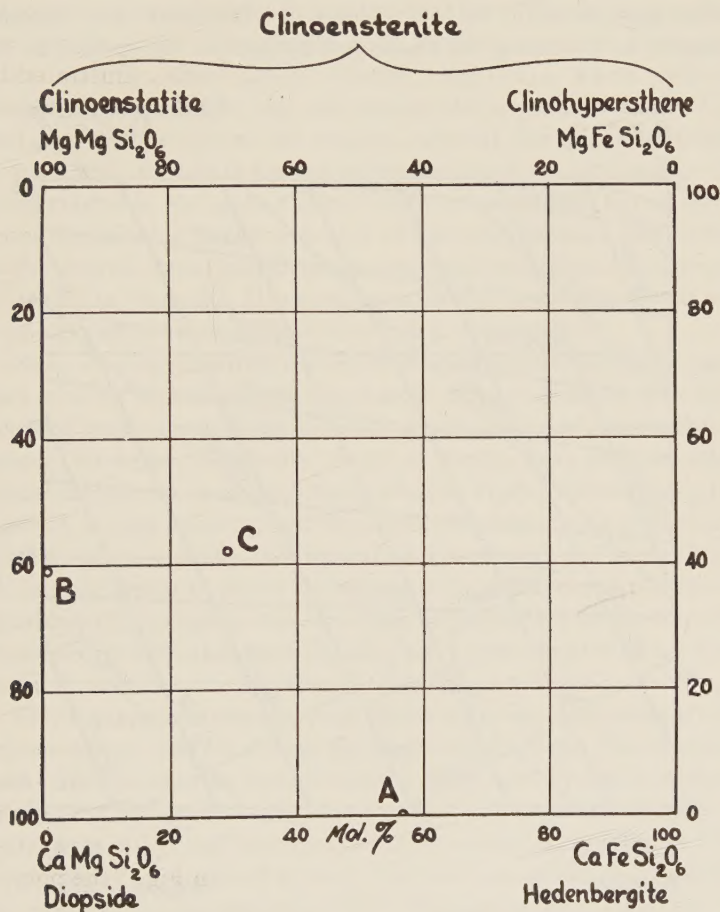


FIG. 3. Variations in composition in the clinoenstatite-diopside-hedenbergite system.

are obtained partly by extrapolation from the properties of the three other end-members of the system.

Thus far, this discussion has dealt only with variations in composition which can be expressed by varying an atom in the formula of a mineral, a procedure which corresponds with replacing (more

or less completely) all the atoms of a certain kind in the crystal structure by atoms of a different kind. Now it has been discovered that some kinds of crystals can change their composition in another way, namely, by losing some of the atoms they normally possess, or by taking on atoms not present in the crystal as first

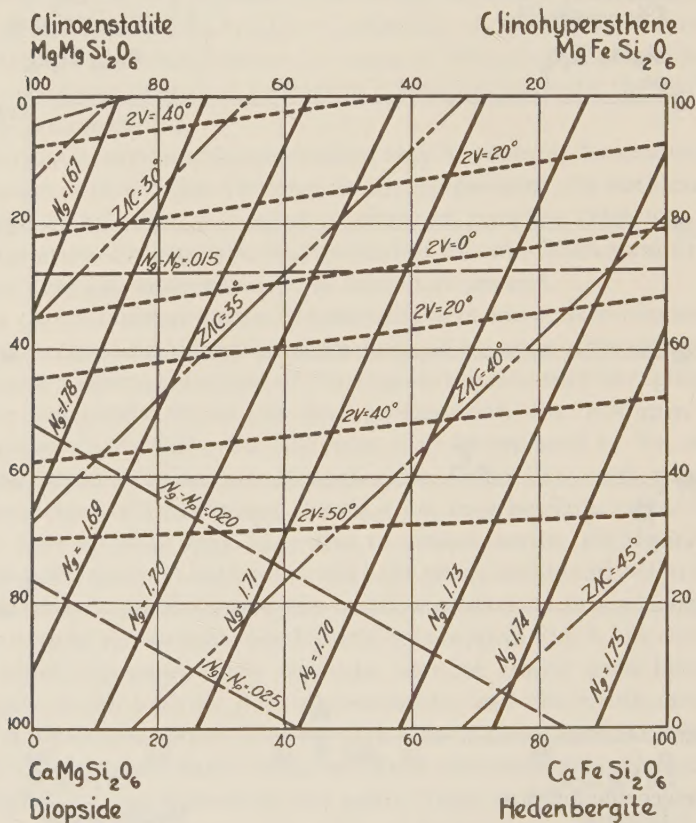


FIG. 4. Variations in composition and optic properties in the clinoenstatite-diopside-hedenbergite system.

formed, or by both these changes. Some changes of this kind lead to substances which can not be produced directly. Let us consider, first, some examples of changes involving loss of constituents. Sulphuric acid attacks biotite in such a way as to dissolve out all the bases and leave merely scales of silica, still possessing the approximate structure and optical properties of a mica. No way is known

to produce such siliceous scales directly. Again, certain zeolites² can be deprived of all their constituents, except SiO_2 , (by treatment with HCl) and the remaining silica (especially after heating) has optical properties closely related to those of the original zeolite. No way is known to produce such zeolite structures from pure silica directly. Once again, brucite, $\text{Mg}(\text{OH})_2$, when properly heated, loses its water, but still retains the approximate structure and optic properties of the original mineral, instead of changing to periclase. No way is known to produce such a structure directly from magnesia. Or again, the hydrogen can be driven out of ferri-ferous amphiboles³ (with oxidation of the iron) without destruction of the crystal structure, although the optic properties change considerably in this case. It seems probable that such anhydrous amphiboles can not form directly from their components.

Next we may consider examples of changes involving the addition of some constituents; such changes are not common probably because most crystallized minerals are close-packed aggregates of atoms. However, magnetite, Fe_3O_4 or Fe_6O_8 , may take on additional oxygen so as to become Fe_6O_9 (or Fe_2O_3) without any important change in its crystal structure, although Fe_2O_3 crystallizes directly to an entirely different structure. Again, the ferrous iron in chlorite seems to be oxidized readily to the ferric state with no considerable change in the structure or properties of the mineral. It seems unlikely that such chlorite can be produced directly from ferric iron oxide and the other necessary constituents.

Third, there are some minerals which may lose some normal constituents and take on others which are not normal. For example, many zeolites may be heated so as to drive out the water without destroying the crystal structure; upon cooling in the absence of water vapor they will absorb alcohol, or ammonia, or CO_2 , or CS_2 , or glycerine, or vapors of mercury, or bromine, or iodine, or merely air, while still retaining essentially the same crystal structure. It is probable that such zeolites have never been formed directly. Also, each calcium atom of a natural zeolite may be replaced by two sodium atoms, or by two silver atoms, or by two copper atoms, or by two thallium atoms; while each pair of sodium atoms of a natural zeolite may be replaced by one atom of calcium, or barium, or strontium. Examples of such zeolites are not unknown in nature,

² F. Rinne: *Crystals and the Fine Structure of Matter*, 1924, p. 243-157.

³ V. E. Barnes: *Am. Mineral.*, XV, 1930, p. 393.

but it seems probable that they were not formed directly. Such exchanges are not confined to zeolites; they are important in soils, and they supply much of the mineral matter needed for plant growth. They are also well shown by other hydrous minerals, as illustrated by calcium uranyl phosphate, called autunite, in which the calcium may be replaced under valence control by sodium, potassium, barium, manganese, copper, lead, or magnesium. Also, the phosphoric acid in this mineral may be easily replaced by vanadic acid, or arsenic acid, apparently without destroying the crystal. It is probable that some of these products of substitution can not form directly.

A very important feature of such changes is that they lead in some cases to products that can not be formed directly; therefore, whenever such products are found in nature, it is possible to reach certain conclusions regarding the history of the rocks in which they are found. For example, zeolites abnormally rich in soda imply that the rocks in which they occur have probably been affected by alkaline solutions since the formation of the zeolites. Chlorites abnormally rich in ferric iron imply that the rocks in which they are found have probably been permeated by hot oxidizing solutions since the formation of the chlorites. Amphiboles deprived of hydrogen and thus containing an abnormal tenor of ferric iron imply that the rocks in which they are found have probably been heated above 800°C . since the formation of the amphiboles. Unfortunately such conclusions are only probabilities at the present time; much more complete knowledge of all the conditions of formation of such products is needed to make similar conclusions certainties.

An illustration of the uncertainties which befog the situation at present is afforded by the facts now available as to the formation of oxydized magnetite or oxymagnite. No way is now known to make oxymagnite crystals directly from Fe_2O_3 , but it is possible to make a mixture of various proportions (up to about 50% Fe_2O_3) of spinel and Fe_2O_3 crystallize with the oxymagnite crystal structure. The variations in composition and optic properties in such a series are shown in Fig. 5, as deduced from the experimental work of Fisk and McCaughey.⁴

These variations have been described and illustrated at some length chiefly to emphasize the main point, which is, that minerals

⁴ *Ohio Univ. Stud., Eng. Ser. I*, July, 1932.

commonly vary considerably in composition and properties. These variations are indeed so common and so great that mineralogists are no longer agreed as to what constitutes a mineral. Many of the mineral names in common use seem to apply most accurately to end-members of a series, or a system, which cannot be divided into parts except by purely artificial rules or limits. This condition is doubtless a direct result of the former view that a mineral had a definite composition corresponding with a simple chemical formula. That view has had other consequences also, some of which are quite

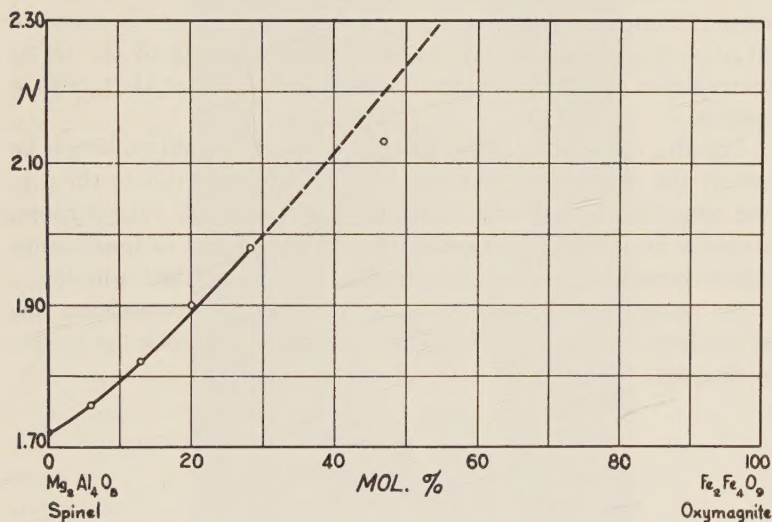


FIG. 5. Variations in composition and refractive index in the spinel-oxymagnite series. Based on data of Fish and McCaughey: *Ohio Univ. Stud., Eng. Ser. I*, July, 1932, page 28.

unfortunate. For example, it is generally recognized that minerals vary in their physical properties. Since they were supposed to be constant in composition, it was formerly held that minerals varied in optical properties in spite of fixed composition, and therefore that accurate measures of optical constants were needless, because of no significance in naming the mineral. It is only very recently and very gradually becoming apparent that any fixed and definite composition within the limits of variation of any mineral has fixed and definite physical characters. This correlation of physical and chemical properties was impossible in many cases as long as the min-

eralogist had no key to unlock the door of his crystal palace. Now that he has entered these palaces he has learned for the first time to understand how they vary in composition; such a knowledge was necessary in order to make it possible to show the relations between physical characters and chemical composition. Such a knowledge was also necessary in order to enable us to discriminate between variations in composition which are possible at the time of formation of the crystal and those which are only possible after the formation of the crystal palace.

The study of minerals in the old way (merely in terms of names) may be compared with the study of animals or plants in terms of isolated species; a mineral (in the proper meaning of the term) corresponds in a certain sense with a genus rather than with a species.

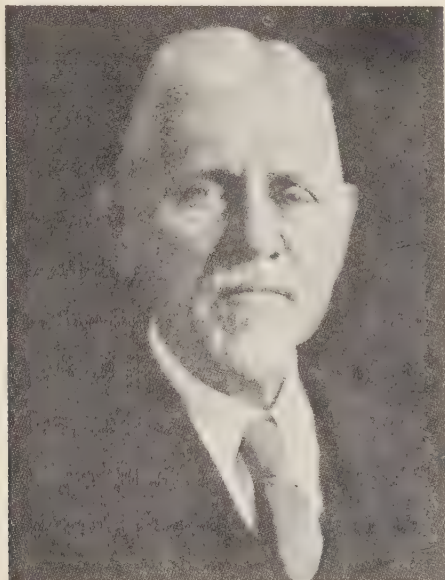
The aim in the scientific studies of minerals should no longer be merely the name of the mineral, but the determination of the precise composition in terms of end-members and, for this purpose, accurate measures of optical constants are second in importance only to complete chemical analyses of carefully purified samples.

By recognizing post-formational changes of composition the mineralogist of the future will have a new key to unlock the secrets of the past.

MEMORIAL OF GEORGE FREDERICK KUNZ

PAUL F. KERR, *Columbia University.*

George Frederick Kunz, known and respected in mineralogical circles for almost sixty years, noted for his wide and extended knowledge of precious stones from all parts of the world, prominent in the affairs of his city, broadly acquainted and versed in the field of general science, unselfish in his service to his fellow men, passed away in New York City, June 29, 1932.



GEORGE FREDERICK KUNZ
1856-1932

Dr. Kunz was born in New York on September 29, 1856, the son of J. G. and Marie Ida Widmar Kunz. At the time of his death he was seventy-six years of age.

The early boyhood of Dr. Kunz was spent in Hoboken where he became interested in collecting minerals from the trap rock ridges of the Palisades and the Watchung Mountains. It is reported that he started exchanging mineral specimens with collectors abroad at the age of fourteen. While still a boy he completed a collection

of 4,000 specimens, weighing two tons, which was sold to the University of Minnesota for \$400. This was the forerunner of several important collections largely assembled through his efforts, the most outstanding being the famous Morgan-Tiffany collection of gems in the American Museum of Natural History. He was also instrumental in interesting the elder Mr. Morgan in the purchase of the Bement Collection for the Museum, and arranged the collection of elements for Morgan Hall.

At the early age of twenty-three Dr. Kunz was made vice-president of Tiffany and Company. His rapid rise in the field of applied mineralogy was accomplished through continuous and devoted effort. He was educated in the public schools and received his more advanced training at Cooper Union. He was a wide and varied reader, however, and much of his practical education was acquired through his own efforts. As evidence of the success of his efforts, his scholarly achievements were recognized by honorary degrees from several institutions including Columbia University (A.M., 1898), University of Marburg (Ph.D., 1903), and Knox University (Sc.D., 1907).

He traveled extensively in his early years, and much of his knowledge was gained through first-hand contact with the leading mineral localities of the United States and Europe. Interest in minerals and gems was continued up to the very end, and many are the friends of the mineralogical clan who have had the pleasure, through his kindness, of holding the Tiffany diamond while visiting the famous store.

Few men have had as wide an acquaintance with precious stones, and particularly their occurrence and distribution, as Dr. Kunz. In addition to his store of knowledge, he assembled one of the best libraries on precious stones in existence. Along Maiden Lane and Fifth Avenue there were few tradesmen who did not have the utmost respect for his judgment concerning the merits of cut stones, particularly of the rarer types.

The varied interests of Dr. Kunz kept him involved in a wide field of activities. He took an active part in the entertainment of distinguished visitors to New York City, particularly scientists. Organizations claiming the honor of his membership included the Mineralogical Society of America, the Geological Society of America, the American Association for the Advancement of Science, New York Academy of Sciences, New York Mineralogical

Club, the New York Bird and Tree Club, the American Scenic and Historic Preservation Society, the American Chemical Society, the American Institute of Mining and Metallurgical Engineers, Société de Chimie Industrielle de France (American section), Century Association, City History Club, and Pilgrims of the United States. In spite of membership in numerous organizations, he was particularly interested in the New York Mineralogical Club. Together with a small group of mineral collectors he organized the club in 1886 and served for many years as its president.

Dr. Kunz was in charge of the department of mines at the Paris Exposition in 1889, the Kimberley (South Africa) exposition in 1892, and the Chicago exposition of 1893. He was honorary special agent of the department of mines at the Atlanta exposition of 1895 and the Omaha exposition of 1898. As a special investigator he served with the U. S. Fish Commission in its investigation of American pearls between 1892 and 1893.

In 1900 he was sent to the Paris Exposition as an honorary special agent to the U. S. Commission General, and served also in that year as United States delegate to the Paris International Congress. He was radium commissioner to the St. Louis exposition of 1904, and had charge of precious stones for the twelfth census.

Foreign honors bestowed upon Dr. Kunz included being elected an officer of the Legion of Honor of France, Knight of the Order of St. Olaf of Norway, and an officer of the Rising Sun of Japan. He was an honorary member of the *Chambre Syndicale Pierres Precieuses* of Paris.

Dr. Kunz was one of the founders and president of the Museum of Peaceful Arts, former vice-president of the New York Academy of Sciences and the American Institute of Mining and Metallurgical Engineers. He was a member of the North American Indian Memorial Commission. He served as special agent for the U. S. Geological Survey from 1883 to 1909, and continued to write annual reports on precious stones until the time of his death. From 1904 to 1918 he served as research curator of gems and precious stones for the Museum of Natural History, and later was made research associate of gems.

Dr. Kunz was president of the association to introduce the metric system into the United States, and all jewelers owe him a debt of gratitude for his efforts in aiding the establishment of the international carat.

The gem kunzite found at Pala, San Diego County, California, and described by Professor Charles Baskerville in 1903 was named in his honor. He was instrumental in the naming of tiffanyite, moissanite, and morganite.

Dr. Kunz was a prolific writer. His contributions include a list of over three hundred articles on gems and minerals, aside from several well known books. Outstanding publications include "Gems and Precious Stones of North America," "The Book of the Pearl," "The Curious Lore of Precious Stones," "E. Roty and His Work," "Magic of Jewels," "Ivory and the Elephant," "Shakespeare and Precious Stones," and "The Ring."

Dr. Kunz married Miss Sophia Hanforth in 1879; she passed away in January 1912. He was married to Miss Opal Logan Giberson in May 1923. The marriage was later annulled, although Miss Giberson assisted in maintaining his household and helped in entertaining up to the time of his death.

Dr. Kunz entered the hospital for medical examination early in June when his health began to fail. He maintained close contact with business interests until June 28. He was stricken with a cerebral hemorrhage, and passed away on the morning of the 29th.

He is survived by a daughter, Mrs. Hans Zinsser, and by two sisters, Mrs. Millie Kunz Guttin and Mrs. Ida Kunz Taggart.

Among benefactions mentioned in the will of Dr. Kunz were gifts to the Mineralogical Society of America, the Mineralogical Collections of Columbia University, the New York Mineralogical Club, the American Scenic and Historic Preservation Society, the New York Academy of Sciences, and the United States Geological Survey. The gifts were directed essentially toward the collection and dissemination of scientific information.

In concluding, it seems fitting to offer the final paragraph of an editorial printed July 2nd in the New York Times in tribute to Dr. Kunz.

It cannot be irreverent to suggest that no one of all men of our day could be more interested in seeing the celestial city whose light is "like unto a very precious stone," or in inspecting the foundations of the wall of jasper adorned with all manner of precious stones: jasper, sapphire, chalcedony, emerald, sardonyx, sardius, chrysolite, beryl, topaz, chrysoprase, jacinth, and amethyst.

ORIGIN AND CLASSIFICATION OF PEGMATITES

(Concluded)

KENNETH K. LANDES, *University of Kansas.*

(Continued from page 56)

CLASSIFICATION OF PEGMATITES

INTRODUCTION

The natural tendency in classifying pegmatites is to use the same nomenclature as is used in rock classification, with (in the case of the pegmatites producing rare minerals) a sub-classification based upon the prevailing type of minerals present. Such classifications have been made by Harker¹⁰⁵ and Palache.¹⁰⁶ Lacroix¹⁰⁷ has developed a chemical classification which is followed by some. An interesting genetic classification has been recently published by Piatnitsky.¹⁰⁸ It follows:

I. Monophasic pegmatites: (a) liquid magma pegmatites; (b) pneumatolytic pegmatites; (c) hydrothermal pegmatites.

II. Polyphasic pegmatites.

In his important contribution on the geochemical-genetic classification of granite pegmatites, Fersman¹⁰⁹ includes a general classification of pegmatites produced by seven different magmas ranging from basic to acidic. He further subdivides granite pegmatites into seven groups and 30 types. The principal basis for the group separation is the presence or absence of contact effects (i.e. "pure" pegmatites, contact pegmatites, migmatic pegmatites) while the types are divided on a basis of characteristic elements or minerals.

The classification submitted below is similar to those of Harker and Palache, with the addition of a division into simple and complex. Simple pegmatites are defined as those in which there has been no hydrothermal replacement. The complex group includes most of the more famous pegmatites, for in them hydrothermal replacement has taken place and rarer minerals have been deposited. The simple pegmatites are classified into rock types according to the relative importance of the mineral constituents. The complex peg-

¹⁰⁵ Harker, A., *Natural history of igneous rocks*, New York, p. 298, 1909.

¹⁰⁶ Palache, Charles, *Advanced mineralogy lecture notes*, 1923.

¹⁰⁷ Lacroix, Alfred, *Mineralogie de Madagascar*, Paris, 1922.

¹⁰⁸ Piatnitsky, P., *Op. cit.*

¹⁰⁹ Fersman, A. E., *Ueber die geochemisch-genetische Klassifikation der Granitpegmatite: Min. Petr. Mitt. (Tschermak)*, 41, 64-83, 1931. Especially Tables I and VI.

matites are similarly classified, except that the hydrothermal minerals, no matter how abundant, are not considered in making the primary grouping. The hydrothermal minerals form the basis for dividing the complex pegmatites into subgroups.

Acidic pegmatites are far more abundant than basic, for two reasons: (1) acidic intrusive magmas are much commoner, and (2) as a general rule pegmatites are more acidic than the plutonic body from which they have been derived. As an illustration of the latter, small bodies of pegmatite containing a little quartz occur in the anorthosites of the Adirondack Mountains,¹¹⁰ cutting the Medford diabase dike¹¹¹ and in the country rock underlying the Duluth gabbro.¹¹² Numerous other examples might be cited.

The cubic volume occupied by complex pegmatites is insignificant when compared with that occupied by simple pegmatites. Naturally, because of the much greater mineralogical interest, the complex pegmatites receive many pages of description in geological literature, while the common pegmatites are but rarely mentioned. Most of the injected (lit-par-lit) pegmatites are of the simple type. The Harney Peak granite in the Black Hills is pegmatitic in texture and its volume is many times the volume of the several complex pegmatites that lie in the surrounding metamorphic rock. The rocks of Maine contain many pegmatites of which the vast majority are of the simple type. Derry¹¹³ has noted the preponderance of simple pegmatites in the pegmatite area of southeastern Manitoba.

CLASSIFICATION

- A. *Acid* (alaskite, normal granite, alkaline granite, granodiorite, quartz monzonite, and quartz diorite)
 - 1. Simple
 - 2. Complex, with following phases (aside from albitization): lithium, fluorine, beryllium, boron, phosphate, graphite, rare earth, ore mineral, and quartz vein

¹¹⁰ Barth, Tom F. W., Mineralogy of the Adirondack feldspars: *Am. Mineralogist*, **15**, no. 4, pp. 136, 1930. Alling, H. L., The Adirondack anorthosite and its problems: *Jour. Geol.*, **40**, no. 3, p. 206, 1932.

¹¹¹ Jaggar, T. A., Jr., an occurrence of acid pegmatites in diabase: *Am. Geol.*, **21**, p. 205, 1898.

¹¹² Grout, F. F., The pegmatites of the Duluth gabbro: *Econ. Geol.*, **13**, p. 187, 1918.

¹¹³ Derry, *Op. cit.*

- B. *Intermediate* (syenite, alkaline syenite, monzonite, diorite)
1. Simple
 2. Complex, with following phases: rare alkaline mineral, calcite, radioactive mineral, and sulphide
- C. *Basic* (gabbro, diabase, anorthosite, and pyroxenite)
1. Simple
 2. Complex (calcite-apatite-phlogopite phase)

DISCUSSION

Under acid pegmatites are included all those that contain free quartz as a primary mineral. As in the case of the normal igneous rocks gradations occur between varieties. The division between granite and granodiorite pegmatites is complicated by the failure of many writers to name the varieties of feldspar present or to distinguish between magmatic and hydrothermal albite. Alaskite and common granite pegmatites are by far the most abundant. The former contain quartz and potash feldspar as the sole magmatic constituents, while the granite pegmatites contain in addition accessory minerals such as muscovite, biotite, garnet, and perhaps common beryl and black tourmaline. The latter two minerals definitely belong to the magmatic stage in pegmatites studied by the writer, although the same species may reappear, often in gem worthy specimens, in later hydrothermal phases. Examples of alaskite pegmatites occur at Baringer Hill, Texas; New Ross, Nova Scotia,¹¹⁴ and Silver Peak, Nevada. The Silver Peak occurrence has been described by Spurr,¹¹⁵ who originated the word alaskite a number of years earlier. According to Schaller's¹¹⁶ paragenetic interpretation, the pegmatites at Pala, California, are alaskite in character. Ordinary granite pegmatites are found on every continent, and are most important sources of muscovite. A good example of this type, occurring in Siberia, has recently been described by Misharev.¹¹⁷ Alkalic granite pegmatites occur in eastern Massa-

¹¹⁴ Cook, C. W., Molybdenite deposit near New Ross, Nova Scotia: *Econ. Geol.*, **20**, p. 186, 1925.

¹¹⁵ Spurr, J. S., The Ore-Magmas, *New York*, p. 325, 1923.

¹¹⁶ Schaller, W. T., The genesis of lithium pegmatites: *Amer. Jour. Sci.*, **10**, pp. 269-279, Sept. 1925. Mineral replacements in pegmatites: *Am. Mineralogist*, **12**, pp. 59-63, March, 1927.

¹¹⁷ Misharev, D. T., Mama-Vitun-Chuisky deposits of mica: *Trans. United Geol. and Prosp. Service, U. S. S. R. Fascicle* **154**, pp. 1-89, 1932.

chusetts and in Oklahoma.¹¹⁸ Pegmatites which may be classified as granodiorite occur near Milford, New Hampshire,¹¹⁹ and in Riverside County, California.¹²⁰ Quartz diorite pegmatites occur in the Adirondacks¹²¹ and in northwestern Manitoba.¹²²

All of the complex acid pegmatites known to the writer exhibit albitization, and in most instances the hydrothermal solutions have produced a series of additional minerals. These may be divided into groups based upon position in the depositional sequence and similarities in chemical composition. In many pegmatites these groups are so well developed that the pegmatite is spoken of as having a lithium phase, or a phosphate phase, or some other phase. In some pegmatites two and even three phases may be represented, while in others the mineral species may be so scattered among the different groups that none are outstanding. Probably the most prominent phase in acid pegmatities is the lithium phase. Examples are Pala, California; Embudo, New Mexico; Keystone, South Dakota; southeastern Manitoba; central Maine; Madagascar; Wodgina, Western Australia; Lunenburg County, Nova Scotia; Üto, Sweden; east Transbaikalia;¹²³ and Pontevedra, Spain.¹²⁴

Pegmatites on St. Peter's Dome in the Colorado Springs area and in the Urga district in Mongolia¹²⁵ have a fluorine phase, and at Ivigtut in southwestern Greenland this phase has produced cryolite to the exclusion of the usual quartz and feldspar. Topaz and fluorite are common accessory minerals in many pegmatites in which phases other than fluorine are dominant.

Although the writer believes common beryl to belong to the

¹¹⁸ Rogers, A. F., Aegirite and riebeckite rocks from Oklahoma: *Jour. Geol.*, **12**, p. 286, 1907.

¹¹⁹ Dale, T. N., The granites of Massachusetts, New Hampshire, and Rhode Island: *U. S. Geol. Survey, Bull.* **354**, p. 48, 1903.

¹²⁰ Dykes, Leland H., Occurrence of monazite in a granodiorite pegmatite: *Pan-American Geologist*, vol. **58**, p. 74, Aug. 1932.

¹²¹ Alling, Harold L., Genesis of the Adirondack magnetites: *Econ. Geol.*, **20**, p. 346, 1925.

¹²² Wright, J. F., Geology and mineral deposits of a part of northwestern Manitoba: *Can. Geol. Survey, Summ. Rept.* 1930, pt. C, p. 20, 1931.

¹²³ Orteniev, B., Materials to the knowledge of the tin deposits of east Transbaikalia: *U. S. S. R. Geol. and Pros. Service, Bull.* **49** (7), 29-45, 1930.

¹²⁴ Gibson, W. B., A new occurrence of spodumene: *Rocks and Minerals*, **7**, no. 1, p. 23, 1932.

¹²⁵ Kryjanowsky, V., Sur les pegmatites des environs d'Urga en Mongolie: *Compt. Rend. Acad. Sci. Russie*, pp. 13-16, 1925. (*Abs. Min. Abstr.*, **3**, p. 439).

magmatic stage of pegmatite development, the white beryl of the Keystone district in the Black Hills, the cesium beryl and rare beryllium minerals of central Maine, the gem beryls of Madagascar, and the aquamarines and emeralds of Brazil, Colombia,¹²⁶ and the Urals are considered to be products of a hydrothermal beryllium phase. Dittler and Kirnbauer¹²⁷ have recently described pegmatites in Roumania containing beryl in two generations. Likewise gem tourmalines and associated rare boron minerals are considered to result from a boron phase in complex pegmatites. Examples of this are Pala, California; central Maine; Haddam, Connecticut; Brazil; Elba; and Ekaterinburg, Russia.

A well developed phosphate phase is not common, although apatite is a widespread pegmatite mineral. Examples of phosphate pegmatites are: Buckfield, Newry, and Poland, Maine; Branchville, Connecticut; Limoges, France; eastern Bavaria;¹²⁸ and Bohemia.¹²⁹

Graphite in Quebec pegmatites, deposited there by solutions of pegmatitic origin, is described by Bain.¹³⁰

A rare earth phase occurs in the granite pegmatites of southern Norway; Ytterby, Sweden; and Llano County, Texas, and in an alkalic granite pegmatite at Cape Ann, Massachusetts.¹³¹ In addition, a great many other pegmatites, such as those in Madagascar, contain a few rare earth minerals.

Hydrothermal magnetite is abundant in some pegmatites (as at Llano County, Texas) and in the New Jersey Highlands it occurs in masses of sufficient concentration to constitute iron ore.¹³² The occurrence in pegmatites of cassiterite and wolframite with other high temperature ore minerals is a matter of common knowledge.

¹²⁶ Piatnitsky, P., *Op. cit.*

¹²⁷ Dittler, E., and Kirnbauer, F., Ueber das neue Beryllvorkommen von Teregovala in Rumänien: *Z. Prakt. Geol.*, **39**, (4), 49–56, 1931. Abs. in *Annot. Bibliog., Econ. Geol.*, **4**, 1, p. 517.

¹²⁸ Laubmann, H. und Steinmetz, H., Phosphatführende Pegmatite des Oberpfälzer und Bayerischen Waldes: *Zeit. Kryst. Min.*, **55**, p. 584, 1915–1920.

¹²⁹ Sellner, Fritz, Die Pegmatite der Umgebung von Marienbad: *Zeits. Krist.*, **59**, pp. 504–512; **60**, pp. 275–277, 1924. (Abs. *Min. Abstr.*, **2**, p. 472.)

¹³⁰ Bain, G. W., *Op. cit.*

¹³¹ Warren, C. H., and McKinstry, Hugh, The granites and pegmatites of Cape Ann, Mass.: *Am. Acad. Arts & Science Proc.*, **59**, no. 14, p. 344, 1924.

¹³² Bayley, W. S., Iron mines and iron mining in New Jersey: *N. J. Survey, Final Report*, **7**, 1910.

Localities illustrating this are Washington State,¹³³ Nova Scotia,¹³⁴ Saxony,¹³⁵ Bolivia,¹³⁶ Cornwall,¹³⁷ New South Wales,¹³⁸ South Africa, and Malaya. Molybdenite occurs in pegmatites in Colorado,¹³⁹ Nova Scotia;¹⁴⁰ Quincy, Massachusetts;¹⁴¹ Pontiac County, Quebec,¹⁴² and many other localities. It often has associated with it other sulphides, such as pyrite, galena, sphalerite and chalcopyrite. The pegmatites associated with the quartz diorite of Shasta County, California, "in places pass over into siliceous masses that are virtually quartz veins and carry sulphides."¹⁴³ Gold has been noted in a number of pegmatites. Examples are Park Valley and Spring Creek districts, Utah;¹⁴⁴ Silver Peak, Nevada;¹⁴⁵ Minas Geraes; Brazil;¹⁴⁶ and Dartmoor, England.¹⁴⁷ The Dartmoor pegmatite is quartz monzonite in composition.

¹³³ Anderson, A. L., Genesis of Silver Hill tin deposits: *Jour. Geol.*, **36**, pp. 646-664, Oct.-Nov., 1928.

¹³⁴ Faribault, R., Lunenburg County, Nova Scotia: *Can. Geol. Survey, Summary Rept.* 1907, pp. 78-83, 1908.

¹³⁵ Vogt, J. H. L., The physical chemistry of the magmatic differentiation of igneous rocks: *Skrifter utgitt av Det Norske Videnskaps-Akademi i Oslo I, Mat.-Naturv. Klasse*, no. 3, second half, 1930, p. 67.

¹³⁶ Ahlfeld, F., Supergene cassiterite in tin veins: *Econ. Geol.*, **25**, pp. 546-548, Aug. 1930.

¹³⁷ Davison, E. H., Mineral associations in Cornish tin lodes: *Mining Mag.*, **43**, pp. 143-149, 1930.

¹³⁸ Cotton, L. A., The tin deposits of New England: *Proc. Linnean Soc. N. S. W.*, **34**, pt. 4, Nov. 24, 1909. (quoted by Lindgren, W.: *Mineral Deposits*, 3d ed., p. 850).

¹³⁹ Butler, B. S., and Vanderwilt, J. W., The climax molybdenite deposit of Colorado: *Colo. Sci. Soc. Proc.*, **12**, no. 10, pp. 309-353, 1931.

¹⁴⁰ Cook, C. W., Molybdenite deposit near New Ross, Nova Scotia: *Econ. Geol.*, **20**, pp. 185-188, 1925.

¹⁴¹ Warren, C. H., and Palache, Charles, The pegmatites of the riebeckite-aeirite granite of Quincy, Massachusetts, U. S. A.; their structure, minerals, and origin: *Am. Acad. Arts & Science Proc.*, **47**, pp. 125-168, 1911.

¹⁴² Thomson, E., A pegmatite origin for molybdenum ores: *Econ. Geol.*, **13**, pp. 302-313, 1918.

¹⁴³ Graton, L. C., The occurrence of copper in Shasta County, California: *U. S. Geol. Survey, Bull.* **430-B**, p. 86, 1909.

¹⁴⁴ Butler, B. S., Ore deposits of Utah: *U. S. Geol. Survey, Prof. Paper* **111**, p. 159, 1920.

¹⁴⁵ Spurr, J. S., *The Ore-Magmas*, New York, 1923.

¹⁴⁶ Derby, Orville A., On the mineralization of the gold-bearing lode of Passagem, Minas Geraes, Brazil: *Amer. Jour. Sci.*, 4th ser., **32**, pp. 185-190, 1911.

¹⁴⁷ Brammall, A., and Harwood, H. F., The occurrence of a gold-bearing pegmatite on Dartmoor: *Mineralog. Mag.*, **20**, pp. 201-211, 1924.

The gradation of ore-bearing pegmatites into quartz veins has already been noted. Such veins are considered to represent a phase in the mineralization of complex pegmatites. Many examples of gradations between pegmatites and quartz dikes have been cited by Tolman.¹⁴⁸ An important addition to this list is a Transbaikalian occurrence recently described by Holmov.¹⁴⁹ Three periods of mineralization are postulated: (1) Pegmatite period. (2) Period of magmatic siliceous solutions, during which tourmaline-quartz, tungsten-quartz, and arsenopyrite-tourmaline veins were deposited. (3) Period of gel solution, during which fluorite-hornblende zones and veins of cryptocrystalline quartz were formed.

Common syenite pegmatites are rare because the pegmatitic offshoots of syenitic magmas are generally more siliceous than the original magmas so that quartz forms during crystallization. Thus the pegmatites associated with the syenite masses of north central Wisconsin¹⁵⁰ contain quartz and should, therefore, be classified as alkalic granite pegmatites. The nephelite-syenites of the same area, however, have associated pegmatites which are simple nephelite-syenite in composition, and the nephelite-syenite of the Haliburton and Bancroft areas, Ontario, contains both simple and complex pegmatitic facies.¹⁵¹ Gillson¹⁵² has described diorite pegmatites occurring in the Adirondacks, and the "soda pegmatites" of Bastin¹⁵³ which occur on both sides of the state line between Maryland and Pennsylvania could perhaps be similarly classified. Other examples are the amphibole pegmatites occurring in northwestern Manitoba¹⁵⁴ and in the Obi Islands in the Moluccas.¹⁵⁵

From a mineralogical point of view, the most interesting of the

¹⁴⁸ Tolman, Carl, Quartz dikes: *Am. Mineralogist*, **16**, pp. 278-299, 1931.

¹⁴⁹ Holmov, George, Minerogenetic sketch of Duldurga tungsten deposit (Transbaikalia): *Trans. United Geol. and Prosp. Service of U. S. S. R. Fascicle 133*, 1931, (English summary, pp. 35-36).

¹⁵⁰ Weidman, S., The geology of north central Wisconsin: *Wis. Geol. and Nat. Hist. Survey, Bull.* **16**, pp. 1-697, 1907.

¹⁵¹ Adams, Frank D., and Barlow, Alfred E., *Op. cit.*

¹⁵² Gillson, J. L., Callahan, W. H., and Millar, W. B., Adirondack studies: *Jour. Geol.*, **36**, pp. 149-164, 1928.

¹⁵³ Bastin, Edson S., Economic geology of the feldspar deposits of the United States: *U. S. Geol. Survey, Bull.* **420**, 1910.

¹⁵⁴ Wright, J. F., *Op. cit.*

¹⁵⁵ Brouwer, H. A., Bijdrage tot de geologie der Obi-eilanden: *Jaarboek van het Mijnwezen in Nederlandsch Oost-Indie*, **52**, pp. 3-62, 1924. (Abs. *Min. Abstr.*, **3**, 1, pp. 37-38.)

complex intermediate pegmatites are those with a rare alkaline mineral phase, such as the alkaline-syenite pegmatites of the Fredriksvårn and Langesunds fjord districts in southeastern Norway.¹⁵⁶ Somewhat similar pegmatites occur in the Kola Peninsula, Russia;¹⁵⁷ and at Magnet Cove, Arkansas.¹⁵⁸ The complex sodalite-syenite pegmatite of the Isle of Rouma¹⁵⁹ off the coast of French Guinea also contains a large number of rare alkalic minerals.

Syenite pegmatites with a calcite phase have been described occurring at several localities, including central Ontario;¹⁶⁰ the Seiland area in Finmarken, Arctic Norway;¹⁶¹ and the vicinity of Laacher See in the German Rhineland.¹⁶² Of unusual interest is a combined calcite-fluorite-radioactive mineral phase in a complex syenite pegmatite at Wilberforce, Ontario, which is described by Spence and Carnochan¹⁶³ and Spence.¹⁶⁴ The pegmatite consists dominantly of feldspar with minor amounts of accessory minerals. Within the pegmatite are a number of cavities one of which is at least 150 feet long by 5 to 10 feet wide and is filled with massive fluorite and calcite. Crystals of apatite, hornblende, magnetite, and uraninite lie embedded within the fluorite-calcite filling. Well developed feldspar crystals line the cavity walls. This pegmatite has been exploited for its radioactive mineral content.

Ore phases in intermediate pegmatites are rare. McLaughlin¹⁶⁵

¹⁵⁶ Brögger, W. C., *Op. cit.*

¹⁵⁷ Fersman, A. E., Ueber die Natur der Pegmatitbildungem: *Compt. Rend. Acad. Sci. Russie*, pp. 89-92, 1924. (Abs. *Min. Abstr.*, 2, p. 399.) Regular intergrowths of minerals in the Khibinsky and Lovozersky tundras: *Bull. Acad. Sci. Russie*, 17, ser. 6, pp. 275-290, 1923. Mineral associations in the Khibinsky and Lovozersky tundras: *loc. cit.*, pp. 65-80.

¹⁵⁸ Landes, K. K., A paragenetic classification of the Magnet Cove minerals: *Am. Mineralogist*, 16, pp. 313-326, 1931.

¹⁵⁹ Lacroix, A., Les pegmatites de la syénite sodalitique de l'île Rouma: *Compt. Rend. Acad. Sci. Paris*, 192, pp. 189-194, 1931. (Abs. *Min. Abstr.*, 4, p. 497.)

¹⁶⁰ Adams, Frank D., and Barlow, Alfred E., *Op. cit.*, p. 158.

¹⁶¹ Barth, Tom, Die Pegmatitgänge der kaledonischen Intrusivgesteine im Seilandgebiete: *Skrifter Norske Vidensk. Akad.*, p. 102, 1927. (Reviewed by Knopf in *Amer. Jour. of Sci.*, Mar. 1928, pp. 272-273.)

¹⁶² Schuster, Ernst., Calcitführende Auswürflinge aus dem Laacher Seegebiet: *Neues Jahrb. Min., Beil.-Bd.*, 43, pp. 295-318, 1919. (Abs. *Min. Abstr.*, 2, p. 123.)

¹⁶³ Spence, Hugh S., and Carnochan, R. K. The Wilberforce radium occurrence: *Can. Min. and Mett., Bull.* 23, pp. 649-688, 1930.

¹⁶⁴ Spence, Hugh S., The pegmatite minerals of Ontario and Quebec: *Amer. Mineralogist*, 15, pp. 480-490, 1930.

¹⁶⁵ McLaughlin, D. H., Copper sulphides in syenite and pegmatite dikes: *Econ. Geol.*, 14, pp. 403-410, 1919.

describes the occurrence of pneumatectic chalcopyrite and bornite in syenite pegmatite in Ferry County, Washington.

Basic pegmatites are relatively scarce, especially the complex types. A large amount of hydrothermal activity following the crystallization of a basic pegmatite magma would not be expected, for the water content of such magmas is probably low. Examples of basic pegmatites are: diorite pegmatites associated with the Adirondack anorthosite;¹⁶⁶ diorite and gabbro pegmatites at Szarvaskő, Hungary;¹⁶⁷ gabbro pegmatites containing plagioclase, augite, diallage, and olivene beneath the Duluth gabbro;¹⁶⁸ diabase pegmatite in Virginia;¹⁶⁹ platinum-bearing dunite pegmatites in South Africa;¹⁷⁰ the coarse labradorite masses in the Labrador anorthosite, and both gabbro and pyroxenite pegmatites in Western Australia.¹⁷¹

A probable example of complex basic pegmatites is the occurrence of phlogopite-bearing pyroxenite pegmatites in Ontario and Quebec. These are described by Spence¹⁷² in his monograph on mica. The following statement appears in a later paper: "These pyroxenites . . . often contain large, irregular cavities lined with well-formed pyroxene crystals and carry a filling of calcite, in which are scattered large apatite and mica crystals . . ."¹⁷³

ACKNOWLEDGMENTS

The writer wishes to thank the following gentlemen for courteous assistance in the preparation of this article: Prof. Charles Palache, for reading and criticizing the manuscript; Mr. M. K. Elias, for translating parts of two articles from Russian into English; and Mr. Vivian Akers of Norway, Maine, for the photographs reproduced in Figures I and II.

¹⁶⁶ Miller, Wm. J., Pegmatite, silicite, and aplite of northern New York: *Jour. Geol.*, **27**, pp. 28–55, 1919.

¹⁶⁷ Szentpétery, S. v., and Ernzt, K., Petrochemische Daten aus der Gegend von Szarvaskő: *Földtani Közlöny, Budapest*, **58** (for 1928), pp. 216–222, 1929. (Abs. *Min. Abs.*, **4**, p. 401.)

¹⁶⁸ Grout, F. F., The pegmatites of the Duluth gabbro: *Econ. Geol.*, **13**, pp. 185–197, 1918.

¹⁶⁹ Shannon, E. V., The mineralogy and petrology of intrusive Triassic diabase at Goose Creek, Loudoun County, Virginia: *Proc. U. S. Nat. Mus.*, **66**, art. 2, 1924.

¹⁷⁰ Vogt, J. H. L., *Op. cit.*, p. 53.

¹⁷¹ Simpson, E. S., Contributions to the mineralogy of Western Australia, Series 6 and 7: *Jour. Royal Soc. West Australia*, vol. **17**, 1930–1931, p. 144; vol. **18**, 1931–1932, p. 67.

¹⁷² Spence, H. S., Mica: *Can. Dept. of Mines*, no. **701**, p. 41, 1929.

¹⁷³ Spence, Hugh S., and Carnochan, R. K., *Op. cit.*, p. 662.

TRIPLITE FROM LA RIOJA PROVINCE, ARGENTINA

E. P. HENDERSON,¹ *U. S. National Museum.*

This mineral was collected by E. F. Burchard of the U. S. Geological Survey, in October of 1925, while studying the iron ore resources of Argentina. It was collected from a stock pile consisting of several tons of this crystalline mineral near the railroad station of Salado, in the province of La Rioja. Dr. Jose M. Sobral, Director of the Bureau of Mines, Geology and Hydrology of the Argentina Republic, who was present at the time endeavored to ascertain the exact location of the deposit but there was reluctance on the part of the shippers to divulge the information so the closest approximation as given by Dr. Sobral is the Sierra de Zapata, Catamarca Province, Argentina.

This triplite has a brilliant resinous luster, a reddish brown color and is free from both mineral inclusions and alteration products. There is a rather prominent zoned structure present and these zones are composed of triplite which has a duller luster and a more pronounced brown color without the reddish tint. When the mineral is powdered and examined under the microscope these different bands are indistinguishable from each other. This triplite does not possess any prominent cleavage although this mineral is described in texts as having two cleavages normal to each other with one much more distinct than the other. The fracture is conchoidal. It has a hardness of 4.5 and a specific gravity equal to 3.87.

The following analysis was made by the author when he was a member of the U. S. Geological Survey.

ANALYSIS OF TRIPLITE

	Percentages	Ratios
Insol.	0.28	
MnO	34.84	.4912
FeO	23.54	.3276
CaO	3.48	.0620
MgO	trace	
Na ₂ O	0.27	.0043
K ₂ O	0.33	.0035
P ₂ O ₅	31.50	.2205
F ₂	6.41	.3371
Cl	trace	
H ₂ O	1.58	.0877
	102.23	
	2.69 F ₂ correction	
	99.54	

¹ Published with the permission of the Assistant Secretary.

The similarity to the triplite formula can be seen more easily if the above analysis is recalculated and expressed as follows:

RECALCULATED TRIPLITE ANALYSIS

FeO	23.54	.3276	2.85 or 3	RO	
MnO	17.01	.2398			
CaO	3.48	.0620			
P ₂ O ₅	31.50	.2205	1	1	P ₂ O ₅
Mn F ₂	15.45	.1673	1.15	1	Mn F ₂ (OH) ₂
MnO (H ₂ O)	7.81	.0878			
	98.79				

Assuming that there is complete isomorphism between the MnF₂ and MnO (H₂O) molecules, this specimen is an intermediate member of the series. The ratios between the MnF₂ and MnO (H₂O) is almost 2:1 respectively.

The optical properties as determined by C. S. Ross are:

$\alpha = 1.675$, $\beta = 1.683$, $\gamma = 1.692$; $\gamma - \alpha = .017$;
sign +; 2V about 80; dispersion $\rho > \nu$. Pleochroism, expressed in color values of Ridgway's scale are: X = 17'0—YG antimony yellow. 2 = 21'0—YYd colonial buff. Absorption X > Y > Z.

It is unfortunate that Mr. Burchard was unable to visit this deposit and furnish a description of its occurrence because any locality which can supply several tons of such fine triplite must be unusual.

PROCEEDINGS OF THE THIRTEENTH ANNUAL MEETING
OF THE MINERALOGICAL SOCIETY OF
AMERICA AT CAMBRIDGE,
MASSACHUSETTS

FRANK R. VAN HORN, *Secretary*.

The Mineralogical Society of America held its thirteenth annual meeting on December 28 and 29, 1932, in conjunction with the Geological Society of America, at Cambridge, Massachusetts, as guests of Harvard University, Massachusetts Institute of Technology, and the Geological Society of Boston. On Wednesday, December 28, at 2.00 P.M., President A. N. Winchell called the regular annual meeting to order in the Mineralogy Lecture Room of the Geological Museum of Harvard University. On motion of the Secretary, the reading of the minutes of the last annual meeting was dispensed with, in view of the fact that they have been printed on pages 108-119 of volume 17, (Number 3) of *The American Mineralogist*.

ELECTION OF OFFICERS AND FELLOWS FOR 1933

The Secretary announced that 161 ballots had been cast unanimously for the officers as nominated by the Council. For fellows, there was a unanimous vote of 66 ballots in the affirmative. All officers and fellows were declared elected.

The officers elected for 1933 are the following:

President: Herbert P. Whitlock, American Museum of Natural History, New York City.

Vice-President: Frank N. Guild, University of Arizona, Tucson, Arizona.

Secretary: Frank R. Van Horn, Case School of Applied Science, Cleveland, Ohio.

Treasurer: Waldemar T. Schaller, U. S. Geological Survey, Washington, D. C.

Editor: Walter F. Hunt, University of Michigan, Ann Arbor, Michigan.

Councilor 1933-1936: Kenneth K. Landes, University of Kansas, Lawrence, Kansas.

The fellows elected follow:

Dr. Victor T. Allen, Associate Professor of Geology, St. Louis University, St. Louis, Missouri.

Lawson H. Bauer, Assistant Chief Chemist, New Jersey Zinc Co., Franklin, New Jersey.

Dr. Joseph P. Connolly, Professor of Mineralogy and Petrography, South Dakota School of Mines, Rapid City, South Dakota.

James Gilluly, U. S. Geological Survey, Washington, D. C.

George Tunell, Geophysical Laboratory, Washington, D. C.

REPORT OF THE SECRETARY FOR 1932

To the Council and Members of the Mineralogical Society of America:

The Secretary herewith begs to report that the roll of the Society now consists of 117 fellows and 280 members in good standing, which is a loss of 28 men over last year. One fellow, Dr. George F. Kunz, and two members, Dr. George I. Adams and R. D. Harvey, have died during the year. It should be noted that Dr. Kunz showed his interest in the Society by leaving a bequest of \$1000.00. In addition to the 397

fellows and members, there are 253 subscribers to the Journal, an increase of 20 over the previous year. Actually, during the past year, 5 fellows, 31 members and 38 subscribers, a total of 74, were added to the mailing list, but deaths, resignations, with non-payment of dues and subscriptions, have reduced the list by 3 fellows, 56 members and 11 subscribers, a total of 70, making a net loss in all classes for the year of 10. A total of 650 paid copies of *The American Mineralogist* are mailed monthly, which is a loss of 10 over last year. It is felt that the Society has done very well to maintain its position with such a small loss under present conditions.

Respectfully submitted,

FRANK R. VAN HORN, *Secretary*

On motion, the report of the Secretary was accepted and ordered filed.

REPORT OF THE TREASURER FOR 1932

To the Council of the Mineralogical Society of America: Your Treasurer submits herewith his annual report for the year beginning December 1, 1931, and ending November 30, 1932.

RECEIPTS

Cash on hand December 1, 1931.....	\$1,224.72	
Dues and subscriptions.....	1,984.74	
Advertisements.....	436.92	
Sale of back numbers.....	173.11	
Interest on endowment.....	2,559.00	
Bank interest.....	3.56	
		\$6,382.05

DISBURSEMENTS

Printing and distribution of the Journal (12 issues).....	\$3,683.06	
Printing and distribution of separates.....	365.43	
To the Editor, Secretary, and Treasurer.....	720.00	
Postage and stationery.....	126.21	
Refunds on dues.....	3.50	
Safety deposit box.....	7.50	
Bank exchange on foreign checks.....	3.44	
Check tax.....	0.40	
Checks returned.....	6.00	
Clerical help, Treasurer.....	32.00	
Filing case, Editor.....	46.55	
Nomenclature Committee (Mimeographing, printing)...	32.47	
	5,026.56	
Cash balance November 30, 1932.....	1,355.49	
		\$6,382.05

The endowment funds of the Society as of November 30, 1932, are the same as a year ago, and consist of:

45 \$1,000 bonds of the City and County of Honolulu, Water Works, 5%, due 1954.	\$45,000.00
4 Liberty bonds, \$100 each, 4th, 4½%, due 1933-1938.	400.00
4 \$100 bonds, Great Northern R. R., 5½% due 1952.	400.00
2 \$1000 bonds, Trenton Mort. and Title Guar. Co., 5½%, due 1937. .	2,000.00
2 \$1000 bonds, Trenton Mort. and Title Guar. Co., 5½%, due 1938. .	2,000.00
1 \$1,000 bond, Denver Gas and Electric Light Co., 5%, due 1951.	1,000.00
	\$50,800.00

Respectfully submitted,
W. T. SCHALLER, *Treasurer*

It was moved that the Treasurer's report be accepted and filed.

Early in December, at the request of the Treasurer, President Winchell appointed an auditing committee consisting of three non-members of the Council, George Tunell, A. H. Koschmann and James Gilluly, all of Washington, D. C., who reported as follows:

Washington, D. C., December 20, 1932

To the President of the Mineralogical Society of America: The Auditing Committee has examined the books of the Treasurer and verified their correctness; the Committee has also verified the presence of the securities belonging to the Society in the safe deposit box in the vaults of the American Security & Trust Co. in Washington, D. C., and certifies that all future coupons are intact and attached to these securities.

GEORGE TUNELL, *Chairman*
A. H. KOSCHMANN
JAMES GILLULY

REPORT OF THE EDITOR FOR 1932

To the Council, Fellows and Members of The Mineralogical Society of America:

In the Editor's report of a year ago it was pointed out that in the sixteen years that the Journal has been in existence, on only three occasions have volumes been issued that have totaled 600 pages. Also, at that time, it was stated that an attempt would be made to again reach that same total in 1932. That year is now drawing to a close and an examination of the December issue of the *Mineralogist* reveals an attainment for the present year only a few pages short of that desired goal. The accomplishments, therefore, for the current year should be considered as very satisfactory, especially at a time when most enterprises are being forced to curtail their operations. It might be mentioned in this connection that sufficient manuscripts were on hand this past year to substantially enlarge the Journal and establish a new record for size, but it seemed a wiser policy to keep expenditures well within our assured income.

It is undoubtedly true that our Society has felt, to a certain extent, the effects of reduced budgets, but the slightly lower income derived from subscriptions, advertisements and from the sale of back numbers, has been offset, in part at least, by a new contract with our publishers which is more favorable to the Society, as the present rates are about 10% lower than a year ago.

In briefly summarizing some of the major points of interest in volume 17, reference should be made to the attractive July issue of 112 pages with 47 illustrations. This special number represents another series of 11 contributions from the Department of Mineralogy and Petrography of Harvard University. This unusually large number was largely instrumental in bringing our total pagination for the year close to the 600 page mark.

Also the number of leading articles published this year is considerably larger than usual. The current volume contains 65 of these contributions which were received from 55 individuals representing 26 different Universities, research bureaus and technical laboratories. Aside from the 65 longer contributions, 13 equally interesting but shorter articles have appeared under the division of notes and news, thus increasing the total number of published manuscripts to 78.

In glancing over the titles of these articles one is impressed with the unusual range of subject matter represented. For here will be found contributions dealing with descriptive, chemical and optical mineralogy; structural and geometrical crystallography; mineralography (=chalcography) and petrography; as well as addresses, memorials and locality articles. Included in the list are the detailed descriptions of seven new mineral species—allegghanyite, galaxite, ashtonite, clinoptilolite, sanbornite, juanite and magnesiosussexite.

Also, as in previous years, considerable space in volume 17 is devoted to book reviews, abstracts of articles in foreign journals dealing with new mineral names, news items and the monthly proceedings of mineralogical clubs and societies.

In some quarters it was felt that our Society should undertake to compile an up-to-date list of the more important mineral collections, both public and private, in the United States and Canada. This arduous task was willingly undertaken by Mr. Samuel G. Gordon of the Philadelphia Academy of Science and after considerable effort, extending over the greater part of two years, by employing published notices in scientific journals, a questionnaire and other means, he was able to collect data on about 700 mineral collections. This material might well serve as a basis of a regional directory. As soon as possible this information, printed in installments, will be made available to our readers.

The concluding table of contents summarizes the distribution of subject matter in volume 17.

DISTRIBUTION OF SUBJECT MATTER IN VOLUME 17

<i>Subjects</i>	<i>Articles</i>	<i>Pages</i>	<i>Per cent of Total</i>
Leading articles			
Descriptive mineralogy.	18		
Chemical mineralogy.	9		
Optical mineralogy.	15		
Structural crystallography and mineralography.	10		
Geometrical crystallography..	3		
Petrography, memorials, etc..	10		
	65	503	87.6

Proceedings of societies	22	25½	} 12.4
Notes and news	35	26	
Abstracts of new mineral names	8	4	
Book reviews	17	17½	
Total of text	147	576	100.0
Illustrations	176		
Covers, advertisements, index		116	
Total		692	

Respectfully submitted,

WALTER F. HUNT, *Editor*

REPORT OF THE NEW COMMITTEE ON NOMENCLATURE AND CLASSIFICATION OF MINERALS

The chairman, W. T. Schaller, announced that the report of the committee had been mailed to the membership. He discussed the report which, upon motion, was accepted with approval. The committee asked that it be continued in order that it might have a meeting with members of a British committee during July, 1933, during sessions of the XVI International Geological Congress.

W. T. SCHALLER, *Chairman*

W. F. FOSHAG

E. S. LARSEN

J. F. SCHAIRER

T. L. WALKER

A. N. WINCHELL

It was moved, seconded and carried that the committee be continued.

REPORT OF THE REPRESENTATIVE ON THE NATIONAL RESEARCH COUNCIL

The representative, C. S. Ross, reported that the National Research Council was to be reorganized with a reduction in the number of members. This would be communicated to the Secretary in due time. The report of the representative was ordered accepted and placed on file.

REPORT OF COMMITTEE ON COOPERATION WITH THE SECRETARY OF THE XVI INTERNATIONAL GEO- LOGICAL CONGRESS ALONG THE LINES OF MINERALOGY AND PETROLOGY

In the absence of W. F. Foshag, Chairman, W. T. Schaller reported that little had been or could be done but suggested that the committee be continued in the event of some emergency arising.

W. F. FOSHAG, *Chairman*

W. T. SCHALLER

J. F. F. SCHAIRER

It was moved, seconded and carried that the committee be continued.

NEW BUSINESS

At the Toronto meeting, a committee was appointed consisting of E. H. Kraus, A. N. Winchell and E. S. Larsen, to investigate the question of a medal to stimulate interest in Mineralogy. The chairman, E. H. Kraus, reported that the committee recommended that the Society initiate such a custom to be known as the Washington A. Roebling Medal for meritorious achievement in Mineralogy and allied sciences. It was further suggested that the sum of one hundred dollars be set aside during 1933 toward the cost of such a medal. It was moved, seconded and carried to adopt these suggestions, and to continue the committee.

It was announced that following the custom initiated at Tulsa, the Society would have an informal luncheon at the Harvard Faculty Club at 12:45 P.M. on Thursday, December 29, and that those interested should notify the Secretary or Professor Charles Palache who was in charge.

MEMORIAL BIOGRAPHY

The only biography was a Memorial of George F. Kunz (died June 29, 1932), which was read by P. F. Kerr.

PRESENTATION OF PAPERS

At 3:11 P.M., there being no further business, the Society proceeded to the reading of scientific papers. The papers presented with short abstracts follow:

R. D. BUTLER AND M. J. BUEGER: *Immersion Liquids of Intermediate Refraction*. Sets of immersion media are placed in two categories; those consisting of a few pure liquids which cover the desired range through the use of the Emmons' double variation method, and those used in ordinary immersion technique, consisting of a series of mixtures of two essentially pure end members. The set described in this paper is of the latter type, utilizing a monochloronaphthalene and a high boiling point kerosene fraction as end members. The liquids closely approach ideal solution, and the properties within the series are strictly continuous from one member to the next. After eighteen months of laboratory use, the properties remain unchanged; the liquids are therefore excellent for ordinary immersion technique, and it is suggested that they might find use in the double variation method.

A. F. ROGERS: *Symbols of Crystal Optics*. The various symbols used for the directions of the optic ellipsoids and for the principal indices of refraction are discussed. Uniformity in the use of these symbols is very desirable.

Arguments are advanced in favor of the use of α , β , and γ for the axes of the triaxial ellipsoid and n_α , n_β , and n_γ for the corresponding indices of refraction. For uniaxial crystals α and γ are used for the axes of the ellipsoid and n_α and n_γ for the corresponding indices.

A. F. ROGERS: *Cleavage and Parting in Quartz*. The absence of cleavage in quartz is stressed in elementary mineralogy, but as a matter of fact imperfect rhombohedral cleavage is rather common for quartz. It is noted in hand specimens and in quartz crystals on the edges of thin sections. A metamorphic quartzose rock from Meteor Crater, Arizona, is unique in that the quartz grains in thin sections show well-defined rhombohedral cleavage.

Unusual vein quartz from a locality in Mariposa County, California, shows prominent parting as well as imperfect cleavage. The parting is either in one direction or in two directions at angles of about 86° . The parting is parallel to the positive unit rhombohedron and is due to polysynthetic twinning.

C. B. SLAWSON: *A New Objective for the Petrographic Microscope*. A variable diaphragm is placed at the rear focal plane of a high aperture objective. This diaphragm may be used to give depth of focus, increase relief, and flatten the field of vision. Interference figures form in the rear focal plane so that by calibrating the objective diaphragm it may be used for direct measurement of the apparent optic angle. The accuracy of these measurements may be greatly increased by using an objective of high aperture but low magnification which gives an interference figure four times larger than the ordinary objective.

G. TUNELL, E. POSNJAK, AND C. J. KSANDA: *Atomic Structure and Geometrical Constants of Tenorite*. The monoclinic symmetry of thin tenorite crystals from Vesuvius was established by Tunell and Posnjak; the proof consisted in demonstration that the extinction position remained stationary when the crystal was rotated around the b axis. The b axis also bisects the angle formed by the traces of the two perfect cleavage planes.

The monoclinic symmetry of an artificial single crystal of cupric oxide prepared for this crystallographic study was established independently by x -ray analysis. The identity of artificial cupric oxide and the thin tenorite crystals from Vesuvius was established by a number of powder photographs. The unit cell dimensions a_0 , b_0 , c_0 , and β of artificial cupric oxide were calculated from measurements made on rotation and Weissenberg pictures.

The structure of tenorite previously described by Niggli was based on powder photographs only and is not correct. The conclusion of Kalkowsky and of Niggli that tenorite is really triclinic (pseudomonoclinic) is without foundation in experiment, and is shown to be erroneous.

J. D. H. DONNAY AND J. MÉLON: *Häuy-Bravais Lattice and Other Crystallographic Data for Sodium Molybdo-Tellurate*. Ideal axial elements for any crystalline species should give as much information as possible regarding the forms which occur on crystals of that species. By mere inspection of such axial elements, one should be able to infer the list of the known crystal forms and their order of importance (frequency of occurrence and perfection of development).

The concept of "simplicity of indices" for the known faces has been much over-emphasized. Axial elements determined from that viewpoint alone have much less significance than axial elements whose choice is based on a correct expression of the Law of Bravais. The method, expounded by G. Friedel in his "leçons de Cristallographie" (1926), is applied to the study of a new compound, sodium molybdo-tellurate, prepared by S. R. Wood.

F. R. VAN HORN AND KENT R. VAN HORN: *X-ray Study of Pyrite or Marcasite Concretions in the Rocks of the Cleveland, Ohio, Quadrangles*. Concretions of iron sulfide have long been found in the Devonian-Mississippian shales and sandstones in the vicinity of Cleveland. In some places pyrite crystals could be identified but in many localities nodular masses were found which showed a massive or columnar radiated structure which was not determinable. In July, 1931, when Bulletin 818 of the

U. S. Geological Survey was published, marcasite was mentioned more frequently than pyrite, consequently in October, 1931, a collection and x-ray study of the occurrences was begun which to date shows the presence of no marcasite in the district. However, the Olentangy shale around Delaware, Ohio, seems to have nothing but marcasite.

After this paper, the Society adjourned at 5:35 P.M., to meet at 9:00 A.M., on Thursday, December 29.

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President Winchell called the second session of the Society to order at 9:10 A.M., on Thursday, December 29, and the reading of papers proceeded according to program.

A. C. LANE: *Five Fold Check of Uraninite Age?* Uraninite contains radioactive elements which disintegrate into Pb_{206} , Pb_{207} , Pb_{208} , and He, as it originally is UO_2 (with some thorium replacing uranium) the uranium originally present might be inferred from the oxygen. When physical data are accurately enough known, we may, assuming insignificant or calculable chemical weathering, have five methods of estimating age, but at present authors vary much as to the values of the physical data for the age. Those for the disintegration from radium to lead seem most reliable, for instance, for the Wilberforce, Canada, uraninite, the age in millions of years is by radium $14260 \log (1 + 1.156 (Pb\ 206 = 7.95)) / (52.00 \text{ to } 44.60) = 985$ to 1850. By actinium, 57160 to $906 \log (1 + 1.153 (Pb\ 207 = .77)) / (0.53 \text{ to } 8.92) = 2290$ to 365. By thorium, 59800 to $39700 \log (1 + 1.115 (Pb\ 208 = .53/10.37)) = 1360$ to 868. By oxygen, $14205 \log (7.46 \times (O = 1006) - \log 53.52) = 1700$.

Varying values come from various data used by different authors.

M. J. BUERGER: *Pyrite-Marcasite Relation*. A critical study of the analyses indicates that while pyrite approximates rather closely to the composition FeS_2 , marcasite is invariably too low in sulfur. Specific gravity and cell volume evidence shows that the additional iron atoms take the places normally occupied by some sulfur atoms. The marcasite structure rather than the pyrite structure is then required by the greater covalence of the iron atoms proxying for sulfur. In general, a marcasite-like packing is also required in any FeS_2 -like compound if the S position is occupied by a heavy atom with many bond possibilities (as in löllingite), and is also favored by large S positions atoms. Thermal agitation is more favorable to the pyrite structure, hence pyrite results at high temperatures. Pyrite and marcasite are not necessarily strictly polymorphous forms of the same compound FeS_2 , because they are chemically distinct.

C. E. TILLEY AND J. F. SCHAIRER: *Some Carnegieite Solid Solutions*. Pure nephelinite ($NaAlSiO_4$) inverts to carnegieite at $1248^\circ C$. In the system, Na_2SiO_3 - $NaAlSiO_4$, this inversion is changed by solid solution with a maximum lowering of the inversion temperature to $1163^\circ C$. In the system, $Na_2Si_2O_5$ - $NaAlSiO_4$, the inversion remains at $1248^\circ C$. Studies of the system, Na_2O - Al_2O_3 - SiO_2 , indicate that the compound $NaAlSiO_4$ is capable of considerable variation due to solid solution.

W. T. SCHALLER: *Johannsenite, A New Manganese Pyroxene*. Johannsenite, named after Professor Albert Johannsen, University of Chicago, is the manganese analogue of diopside and hedenbergite. Its formula is MnO , CaO , $2SiO_2$, this compound being dimorphous, the other modification with lower density, refractive indices, and birefringence, being bustamite.

Johannsenite occurs as a hydrothermal vein forming pyroxene in the Bohemia district, western Oregon, and as a product of contact metamorphism at Schio-Vicentin in northern Italy. One specimen from Italy contains about 95 per cent of the MnO , CaO , 2SiO_2 , molecule, while a second specimen from the same locality has about 16 per cent each of isomorphous diopside and hedenbergite. The mineral from Oregon contains about 12 per cent each of diopside and hedenbergite.

Johannsenite has the typical diopside structure, as shown by x -rays. Optical orientation agrees with monoclinic symmetry, the axial plane is parallel to b (010), optically positive with medium large axial angle, large extinction angle, polysynthetic twinning, and the indices of refraction are: $\alpha=1.709$, $\beta=1.718$, $\gamma=1.738$.

R. E. LANDON: *Colusite, A New Tin-Bearing Tennantite from Butte, Montana.* (Read by title.) Small amounts of tin in ores from the Leonard, West Colusa, Mountain View, and Tramway Mines of the Anaconda Copper Mining Company at Butte, Montana, have been noted for a number of years. The tin-bearing mineral was provisionally named "colusite" after the Colusa claim near which it occurs. Its chemical composition corresponds to tennantite, with tin isomorphous with copper. Its physical properties are similar to tennantite excepting for its color which is bronzy. Under the polarizing microscope colusite is isotropic, and its polished surface has the peculiar color of the so-called "pink enargite." It is contemporaneous with tetrahedrite from which it separated, producing the well-known unmixing texture.

PHILIP KRIEGER: *Occurrence of Strontianite at Sierra Mojada, Mexico.* The occurrence of strontianite in unusually large quantities as one of the principal gangue minerals associated with lead and silver ores at Sierra Mojada differs in several important respects from other mineralizations in this well known district. So far as known, strontianite has not been observed as a gangue mineral, even in minor amounts, in any of the ore bodies previously mined in this district. In the comparatively recently discovered Suiza ore body, however, it is one of the principal gangue minerals. The occurrence of strontianite and its association with the ore in the Suiza body has been noted over a horizontal distance of approximately 3,500 feet. The abundance of strontianite over such a distance and its apparent confinement to the one ore body presents an interesting problem in limestone replacement deposits. From a study of this section and the association of strontianite with the ore, it appears that strontium must have been an important constituent of the same solutions which were responsible for ore deposition.

W. A. TARR: *Origin of the Sand Barites of the Lower Permian of Oklahoma.* (Read by C. J. Roy.) The Garber formation (a sandstone) of the Enid group of the Lower Permian of south central Oklahoma contains barite rosettes (concretions) along a number of horizons, but especially in the lower 200 feet. These sand barites are aggregates of barite crystals that incorporated the sand in which they were deposited. The origin of the barite in these sand crystals is discussed.

J. S. STEVENSON: *Vein-like Masses of Pyrrhotite in Chalcopyrite from the Waite-Ackerman-Montgomery Mine, Quebec.* The paper presents a study of some peculiar masses of pyrrhotite which were found in specimens of ore from the Waite-Ackerman-Montgomery Mine. The most interesting habit of the pyrrhotite is that of small vermiform masses. The author concludes that the latter are neither residual

nor introduced veins but are the results of exsolution. The vermicules are attributed to exsolution because each consists of but one crystal, they are intergranular with respect to the chalcopyrite and are not developed in the sphalerite or magnetite but only in the chalcopyrite.

P. F. KERR: *Tungsten Deposit at Mill City, Nevada*. The most important tungsten mine in the United States is located near Mill City, Nevada. Scheelite ore occurs in a series of steeply inclined and metamorphosed beds in hornfels. The mineralized beds were originally limestone, but in the vicinity of an igneous intrusion have been altered, forming a group of contact minerals containing scheelite.

Two generations of faults have cut the ore bodies: one previous to metamorphism, the other following it. The scheelite-bearing layers have been split by these faults into a series of segments.

Granitic dikes cut the mineralized beds in various directions. Intense silicification has followed this phase of the intrusion, and appears to be connected with the introduction of the scheelite.

STEPHEN RICHARZ: *Peculiar Gneisses of a Late Formation in the Cascades, Washington*. The paper deals chiefly with gneisses of Tertiary or late Mesozoic formation in the Cascades, Washington. The gneisses are migmatites of argillaceous and of igneous material. The injected material, free of potassium feldspar, must have been derived from an intrusive granodiorite to quartz diorite which is in contact with the gneiss. However, only the more acid portions of this intrusive were injected into the argillaceous sediment, in which besides mica and quartz, garnet and cyanite developed.

The contact of diorite and gneiss is marked by a fault zone accompanied by crushing and decomposition and mineralization on a large scale. The main ore is pyrrhotite, frequently associated with chalcopyrite, sphalerite and, at places, with arsenopyrite.

CHARLES PALACHE AND EDWIN OVER, JR.: *Pegmatites of the Pikes Peak Region, Colorado*. The distribution of the pegmatites in the Pikes Peak granite is shown areally and their relation to occurrences of fluorine-bearing compounds is traced. There seems to be considerable evidence of a late period of fluorine replacement at least in some parts of the region. The origin of the zircon at St. Peter's Dome in the same region was described.

At 11:47 A.M., the Society adjourned to meet at 12:00 o'clock, noon, in joint session with the Geological Society of America, and listen to the presidential address of our retiring president, Dr. A. N. Winchell on "The New Mineralogy."

LUNCHEON MEETING

An informal luncheon meeting was held at 12:45 P.M., Thursday, December 29, at the Harvard Faculty Club. This was attended by 51 persons, and was presided over by Vice-President Joseph L. Gillson who asked each one present to rise, give his name, position, and sphere of interest in mineralogy. The meeting was enjoyed by all present.

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The third session was called to order at 2:15 P.M. by President Winchell, and the reading of papers proceeded according to program.

A. F. ROGERS: *Use of Plane Angles in Geometrical Crystallography*. Modern works on crystallography give practically no information concerning plane angles of crystal faces, evidently on account of the difficulty of accurate measurement of these angles.

Plane angles are as characteristic as interfacial angles and it seems probable that many of the more common crystallized minerals are recognized by means of these plane angles. A method of determining plane angles graphically was shown.

J. D. H. DONNAY: *Theory of Determinants Applied to Crystallography*. The theory of determinants and matrices is a very useful tool in a great many questions in physics and mathematics, such as problems which involve systems of linear equations in several variables. Such problems are often encountered in crystallography where the methods of solid analytical geometry find constant application.

The aim of the paper is to present the results of the application of determinants to the study of tautozonal faces. The derivation of the equation of zone control is greatly simplified. So is the demonstration of the "Law of Addition and Subtraction," a special case of the latter equation.

CHARLES PALACHE AND LAURENCE LA FORGE: *Crystallographic Notes*. The minerals anapaite and eudidymite are described with the choice of new positions for the axes and reasons given therefore. They serve as an illustration of some of the problems met with in the revision of crystallographic data for the new edition of Dana's SYSTEM.

M. A. PEACOCK: *Crystallography of Emplectite*. Crystals of this mineral, apparently of much better quality than any measured before, have yielded a series of 26 forms and a new axial ratio. The new crystals clarified the relation with zinkenite and chalcostibite.

A. H. KOSCHMANN: *Differentiation as Expressed by Intrusive Stocks in the Magdalena District, New Mexico*. In the Magdalena district, pre-Cambrian, Carboniferous, and Tertiary rocks are cut by several Tertiary stocks. Attention is here confined to four closely related stocks that consist mainly of monzonite and granite, with gabbroic and granophyric facies.

One stock, which consists almost entirely of typical monzonite, has a chilled apophysis whose composition is that of a gabbro, and indicates an original gabbroic magma from which the rocks of the stocks have been differentiated in situ. However, margins of the main stock are typical monzonite. This stock and adjacent rocks are cut by small salic dikes, some of which approach typical granite aplite in composition, and some contain considerable epidote.

Other stocks are more complex. In one, typical monzonite grades into typical granite and the granite into granophyre; in another, monzonite grades directly into granophyre.

S. S. PHILBRICK (Introduced by E. B. Mathews): *Contact Metamorphism of the Onawa Batholith, Piscataquis County, Maine*. Within a wide belt of regionally metamorphosed slate, which occupies much of south central Maine, are several small, apparently concordant, intrusive granitic bodies. One of these is the Onawa Batholith. The granite with its basic border occupies an area of about 33 square miles and forms a complex physiographic basin which is surrounded by ridgelike mountains produced by strongly resistant contact metamorphic rocks.

The metamorphic rocks are divided into three zones forming an aureole about three-quarters of a mile in width which surrounds the entire batholith with breaks in only two places. The zones, proceeding from the country slate toward the batholith, are: (1) andalusite (frequently chiastolite) schist, (2) andalusite hornfels, and (3) injection hornfels carrying many small quartz-microcline aplites.

J. T. ROUSE (Introduced by F. R. Van Horn): *Structure and Alteration of the Deer Creek Intrusive, Wyoming*. A detailed study and structural survey has been made of a small laccolith on Deer Creek, a tributary of the south fork of the Shoshone River, near Valley, Wyoming. The laccolith is composed of quartz-diorite-porphry intruded in Tertiary (Eocene?) basic breccias and basalt flows. This intrusive was first mapped as a stock and then later considered a sill, but the structural survey, especially the direction of alignment and pitch of the hornblende needles, showed it to be a laccolith. It is believed that the difference between the outer undecayed rock and the central decayed zone is due to hydrothermal alteration of the rock.

J. W. PEOPLES (Introduced by Edward Sampson): *Stillwater Igneous Complex, Montana*. A study of a banded igneous complex exposed for a length of thirty miles along the Beartooth Mountain front, Montana, has shown that it is a sheet, or lopolith, of pre-Cambrian age intrusive into pre-Cambrian sediments; that it has a basal chill zone of norite; that its top has been eroded; that each extremity is probably faulted; and that, as now exposed, it has a total thickness of about 11,000 feet.

Three zones are distinguished: a lower, or basic, zone of bronzitite, harzburgite, and related rocks; a middle, or banded, zone of norite, anorthositic norite, anorthosite, and troctolite, and an upper zone of anorthosite, anorthositic gabbro (or norite), gabbro, and norite.

H. N. FISK (Introduced by F. R. Van Horn): *Differentiation in Columbia River Basalt*. A glassy basalt flow, sixteen feet thick, from Grand Coulee, Wash., was sampled at one foot intervals. Each specimen was sectioned both parallel to and normal to the surface of flow. Work to date shows the holocrystalline portion of the flow limited to the lower two feet where there is a concentration of magnetite and olivine. Above this, augite and magnetite vary inversely with the percentage of tachylyte which is frequently rendered opaque by these minerals in a finely divided state. The percentage of plagioclase is remarkably constant throughout the flow, with a tendency toward the concentration of more basic plagioclase in two definite horizons.

T. F. W. BARTH AND C. J. KSANDA: *Structure of the Polymorphic Forms of Niter*. Potassium nitrate, KNO_3 , an orthorhombic form of which is known as the mineral niter, has two additional modifications, both trigonal, one of these being stable at higher pressures, the other at higher temperatures.

In these two modifications the same general type of crystal structure is encountered (related to that of calcite), but the pressure form displays a space lattice in which all the atoms have stationary positions, whereas in the high-temperature form the group NO_3 is rotating around the central N-atom.

ALFRED C. HAWKINS: *Beidellite in the Cretaceous Clays of New Jersey*. Microscopic crystals observed during microscopic study of the fire clays of Middlesex Co.,

N. J., prove to be a kaolin mineral which is much like beidellite, but in its optical properties shows a tendency toward nontronite.

The crystals appear monoclinic. They are well developed and angles can be measured and some optical properties determined. This must be a new mineral. (Identification checked by C. S. Ross.)

ALFRED C. HAWKINS: *Helically Twisted Millerite Crystals*. The millerite crystals occur in cavities of a quartz vein which cuts the Mills coal vein at Nanticoke, Pa.

The crystals are brilliant and untarnished. The coarser ones have a radiated arrangement; many smaller ones form a felt of matted acicular prisms. A number of the most slender ones have a very regular helical twist, which must have been developed during the growth of the crystals.

S. G. GORDON: *The New Museum Cases of the Academy of Natural Sciences of Philadelphia*. (Read by title.)

The last paper was finished at 5:13 P.M., after which Dr. A. C. Hawkins moved that the thanks of the Society be extended to the authorities of Harvard University, Massachusetts Institute of Technology, the Geological Society of Boston, and to the local committee, for their kindness and hospitality. This was seconded by Dr. J. Ellis Thomson after which the Society adjourned.

During the sessions of the Society, a total of thirty-one scientific papers were presented, two being read by title. 102 fellows, members, and guests were present at the various meetings.

The following registered at the Cambridge meetings:

W. M. Agar	N. G. Dumbros	A. H. Koschmann
J. Anshel	F. C. Edson	P. Krieger
E. J. Armstrong	C. M. Farnham	L. LaForge
V. L. Ayers	C. R. Fettke	A. C. Lane
G. J. Baker	L. W. Fisher	E. S. Larsen
J. W. Baker	H. N. Fisk	J. V. Lewis
T. F. W. Barth	F. Foreman	G. D. Louderback
J. S. Beach	D. Gallagher	G. F. Loughlin
N. S. Beaton	E. A. Goranson	H. E. McKinstry
N. L. Bowen	J. L. Gillson	E. B. Mathews
M. L. Brashears, Jr.	J. Gilluly	J. E. Maynard
L. S. Brown	F. A. Gonyer	E. B. Mayo
A. F. Buddington	G. M. Hall	B. L. Miller
M. J. Buerger	J. B. Hanley	C. E. Miller
N. W. Buerger	A. C. Hawkins	R. B. Miller
R. D. Butler	C. S. Hitchen	D. Modell
R. J. Colony	G. R. Heyl	E. S. Moore
F. M. Chase	H. C. Horwood	J. F. Morton
H. D. Chase	W. F. Hunt	J. H. Moses
N. E. Chuté	C. S. Hurlbut, Jr.	R. Murphy
M. E. Cooley	F. E. Ingerson	C. Palache
L. W. Currier	E. C. Jacobs	M. A. Peacock
C. G. Doll	P. F. Kerr	J. W. Peoples
J. D. H. Donnay	A. A. Klein	E. H. Perkins
R. K. Doten	E. H. Kraus	E. L. Perry

S. S. Philbrick	J. F. Schairer	T. L. Tanton
A. H. Phillips	W. T. Schaller	E. Thomson
A. W. Quinn	G. F. Seager	G. Tunell
S. Richarz	G. Selfridge	F. R. Van Horn
A. F. Rogers	B. M. Shaub	S. Varni
C. S. Ross	C. B. Slawson	T. L. Walker
J. T. Rouse	L. W. Staples	R. C. Wells
C. J. Roy	L. F. Stevens	E. Wigglesworth
E. Sampson	J. S. Stevenson	A. N. Winchell

LIST OF FORMER OFFICERS AND MEETINGS, WITH DATES

By recommendation of the Council, a complete list of past officers is printed in the proceedings of the annual meeting of the Society.

HONORARY PRESIDENT for life.....Edward S. Dana, 1925

PRESIDENTS

1920 Edward H. Kraus
 1921 Charles Palache
 1922 Thomas L. Walker
 1923 Edgar T. Wherry
 1924 Henry S. Washington
 1925 Arthur S. Eakle
 1926 Waldemar T. Schaller
 1927 Austin F. Rogers
 1928 Esper S. Larsen
 1929 Arthur L. Parsons
 1930 Herbert E. Merwin
 1931 Alexander H. Phillips
 1932 Alexander N. Winchell

VICE-PRESIDENTS

1920 Thomas L. Walker
 1921 Waldemar T. Schaller
 1922 Frederick A. Canfield
 1923 George F. Kunz
 1924 Washington A. Roebling
 1925 Herbert P. Whitlock
 1926 George Vaux, Jr.
 1927 George L. English
 1928 Lazard Cahn
 1929 Edward Wigglesworth
 1930 John E. Wolff
 1931 William F. Foshag
 1932 Joseph L. Gillson

SECRETARIES

1920-1922 Herbert P. Whitlock
 1923- Frank R. Van Horn

TREASURERS

1920-1923 Albert B. Peck
 1924-1929 Alexander H. Phillips
 1929-1930 Albert B. Peck
 1931- Waldemar T. Schaller

EDITORS

1920-1921 Edgar T. Wherry
 1922- Walter F. Hunt

COUNCILORS

1920 Arthur S. Eakle, Frank R. Van Horn, Fred E. Wright, Alexander H. Phillips
 1921 Frank R. Van Horn, Fred E. Wright, Alexander H. Phillips, Austin F. Rogers
 1922 Fred E. Wright, Alexander H. Phillips, Austin F. Rogers, Thomas L. Watson
 1923 Alexander H. Phillips, Austin F. Rogers, Thomas L. Watson, Esper S. Larsen
 1924 Austin F. Rogers, Thomas L. Watson, Esper S. Larsen, Arthur L. Parsons
 1925 Thomas L. Watson, Esper S. Larsen, Arthur L. Parsons, William F. Foshag

- 1926 Esper S. Larsen, Arthur L. Parsons, William F. Foshag, William A. Tarr
1927 Arthur L. Parsons, William F. Foshag, William A. Tarr, Alexander N. Win-
chell
1928 William F. Foshag, William A. Tarr, Alexander N. Winchell, Ellis Thomson
1929 William A. Tarr, Alexander N. Winchell, Ellis Thomson, Clarence S. Ross
1930 Alexander N. Winchell, Ellis Thomson, Clarence S. Ross, Paul F. Kerr
1931 Ellis Thomson, Clarence S. Ross, Paul F. Kerr, William S. Bayley
1932 Clarence S. Ross, Paul F. Kerr, William S. Bayley, William J. McCaughey

ANNUAL MEETING PLACES

- 1920 Chicago, Illinois
1921 Amherst, Massachusetts
1922 Ann Arbor, Michigan
1923 Washington, D. C.
1924 Ithaca, New York
1925 New Haven, Connecticut
1926 Madison, Wisconsin
1927 Cleveland, Ohio
1928 New York, New York
1929 Washington, D. C.
1930 Toronto, Canada
1931 Tulsa, Oklahoma
1932 Cambridge, Massachusetts

Errata

In volume 18, page 8, bottom part of page: The axial ratio which is given as a_0/c_0 (line 6 from bottom), and a'/c' (line 5 from bottom), should be reversed so as to read c_0/a_0 and c'/a' , respectively.

Page 13, 4th line of Summary: The axial ratio should be reversed so as to read c_0/a_0 .

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PROCEEDINGS OF SOCIETIES

NEW YORK MINERALOGICAL CLUB

Minutes of the Meeting of November 18th, 1931

A regular monthly meeting of the New York Mineralogical Club was held at the American Museum of Natural History on the evening of November 18th, 1931, with an attendance of 86. President Allen was in the Chair.

Miss Fannie Moses and Dr. Walter J. Reichert of New York; Miss Ruth Slack and Mr. Bernard Wuensch of Paterson, N. J.; and Mr. Stanley Saxton of Fairlawn, N. J., were elected to membership.

Mr. Morton reported on the Election Day excursion of the Club, to the quarries at W. Paterson and Prospect Park, N. J., which was enjoyed by about sixty people, nineteen different minerals being found. Motion pictures of the excursion were shown.

Professor R. J. Colony of Columbia University addressed the Club on "The Source of the Beach Sands of Long Island and New Jersey." The U. S. War Department investigated the behavior of these sands with reference to inlets, breakwaters and piers. The sampling and testing were described. The working hypothesis was proved correct: That the sands that form the beaches should reflect the character of the rocks from which they were derived. Lists of the minerals and rocks found were given. It was decided that the movement of sand along the New Jersey shore north of Asbury Park is northward; south of Asbury Park, southward; and along the Long Island shore, from east to west. The lecture was illustrated by lantern slides.

Discussion of the subject followed. A rising vote of thanks was tendered Dr. Colony for his very interesting talk.

DANIEL T. O'CONNELL, *Secretary*

Minutes of the Meeting of December 16th, 1931

A regular meeting of the New York Mineralogical Club was held at the American Museum of Natural History on the evening of December 16th, 1931, with an attendance of 82. President Allen was in the Chair.

Mr. A. L. Queneau, Mr. Glenn H. Niles, and Miss Pauline Merrill Cronon, of New York City; Mr. Peter Zodac of Peekskill, N. Y.; Mrs. Sophia De Remer of Ozone Park, L. I.; and Miss Beulah Blumenthal of Brooklyn, N. Y., were elected to membership.

Professor Bertram T. Butler of The College of the City of New York spoke on "New York in the Geologic Past." He reviewed the periods of geologic time, and then drew a blackboard sketch giving a cross-section of the present stratigraphic and structural geology from Manhattan Island to the First Watchung Mountain at Paterson, N. J. Professor Butler traced the rocks of New York from early pre-Cambrian times through foldings, erosion, elevations, and subsidences to the present aspect at the close of the Ice Age.

A rising vote of thanks was given Professor Butler for his delightful presentation of the geologic history of our city and its environs.

DANIEL T. O'CONNELL, *Secretary*

Minutes of the Meeting of January 20th, 1932

A regular meeting of the New York Mineralogical Club was held at The American Museum of Natural History on the evening of January 20th, 1932, with an attendance of 60. President Allen was in the Chair.

The resignation of Mr. Roland Jackson Hunter of Freehold, N. J., was accepted.

The preparation of an elementary manual for the beginner in mineralogy was discussed. President Allen named Messrs. Morton, Ehrmann and Engel as a committee to consider the advisability of the preparation of such a manual as a club document.

The gathering was delighted by a "Symposium on Quartz." Every phase of the subject was considered, from sentimental to economic, in all its forms, natural and artificial. The following participated: President Allen, Dr. R. B. Sosman, Dr. Olaf Anderson, Miss Catherine Schroder, and Messrs. H. R. Lee, Radu, Maynard, Broadwell, Grenzig, Morton, Ashby, O'Connell, and Strock.

The Club learned with regret of the death on December 23, 1931, of Wilson C. Bentley, internationally famed photographer of snow-crystals, of Jericho, Vermont.

DANIEL T. O'CONNELL, *Secretary*